Crustal Structure across the Qilian Orogenic Belt from In-line and Off-line Wide-angle Seismic Profiling in the North-eastern margin of Tibetan plateau

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The Qilian orogenic belt, located at the north-eastern edge of the Tibet, is a Caledonian orogenic belt reactivated by collision between India and Asia. GPS measurements indicate the Tibetan plateau is expanding to the northeast, and the Qilian tectonic block is an important place to understand this north-eastward expansion. In order to reconstruct crustal structure beneath the Qilian Shan tectonic block and to provide constraints on the Caledonian orogenic structure and lateral (N-E) expansion of the plateau, we carried out a wide-angle seismic experiment in 2008 and 2009 along a 430-km-long inline profile across the Qilian orogenic belt and along a 300-km-long cross-line profile, with support of SinoProbe-02-02. We present a crustal P-wave velocity structure model along the in-line wide-angle seismic profile, and find crustal thickness thins from about 52 km under the southwest end of the profile to about 49 km at the northeast end of the profile, which is consistent with the results from previous wide-angle seismic profiling by Liu and others (2006) and Zhang and others (2008). Notable features of the crustal velocity model include: (1) the Kunlun (or the western Qingling block) and the Qaidam block are clearly distinguished, with the northern margin fault of the western Qingling Mountains as the boundary between them; the crust of these two tectonic blocks is thickened both in the upper and lower crust, and their crusts can be divided into upper and lower crust with thickness about 27 km and 22-26 km, respectively; (2) P-wave velocity is very low for the whole crust, especially in the lower crust (6.3-6.6 km/s) beneath the Qilian terrain; (3) there is one lower-velocity layer (about 5.7 km/s) with thickness of 7-8 km in the upper crust beneath the south segment of the profile, and a 6.2-6.3 km/s higher-velocity layer with thickness of about 5 km in the upper crust beneath the north segment of the profile; (3) the Southern Qilian fault that bounds the early Paleozoic North Qaidam UHP metamorphic belt is of crustal scale, implying continental collision of the Qaidam block with the Qilian terrane that seems inconsistent with the paired subduction model of Yang and others (2002), but may support a transition from oceanic subduction (along the Northern Qilian fault) to continental collision (along the Southern Qilian fault belt) as suggested by Song and others(2006); (4) a lower-velocity zone in the depth range 25-30 km beneath the Qilian terrain is inferred to be a zone of partial melt that may be related to the thermomechanical evolution of UHP metamorphic rocks or diapiric flow of subducted continental crust (Yin and others, 2007). Analysis of individual seismic shots suggests that strong seismic reflections from the lower crust are weak or absent on in-line shot gathers, suggesting a transparent lower crust beneath the Qilian tectonic block, but in contrast well-developed reflections are seen on the off-line shot gathers. This discrepancy in the appearance of crustal reflections between NE-SW and NW-SE azimuths, and the very low crustal velocity, may suggest northeastern Tibet grows predominantly in the NW-SE direction, which matches with surface GPS measurements.

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